

Structural Method Statement

45 Cholmeley Crescent

SD Engineers Project Reference
SDS1711

Issuing Date
08/08/2023

Revision Number
1

Document Reference
RP01





Document Control

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1. Introduction

This document is provided in accordance with Haringey Councils' SPD, to support a planning submission for an extension to the rear of the property's existing lower ground floor, below the existing main house. This document should be read in conjunction with document *MGC-132-BIA-V1* produced by Maund Geo-Consulting LTD which contains a detailed desk study, basement impact assessment and the findings from the intrusive site-specific investigation to understand the existing ground conditions.

This document summarises the structural design principles for both the basement and superstructure works, while commenting on anticipated methods of construction and methods for managing and mitigating any effects associated with the works.

1.1. Existing Property

45 Cholmeley Crescent is a semi-detached property located in Haringey, London. The building is assumed to be of traditional construction with solid brick walls, brick corbel footings and timber joisted floors. There is an existing loft conversion that makes up the second floor of the property. The existing roof is a hipped timber roof, with existing dormers to the rear, front and side. The property is built into a slope that extends from low level at the front, to high level towards the rear. Because of this, the property has an existing lower ground floor beneath only the front half of the property. This is to be extended as a basement during the proposed works.

1.2. Proposed Works

The proposal is to refurbish the existing property with a single storey rear extension above ground, internal alterations throughout, and to extend the existing lower ground floor to a basement across the entire layout of the property (including the new rear extension). It should be noted that the proposals shown in this document may be refined during the design process, but the principles for minimising ground movement and avoiding adverse effects on neighbouring structure will remain the same.

1.3. Site

The site is located at 45 Cholmeley Crescent, N6 5EX, in the London Borough of Haringey and is a semi-detached property. The site is approximately 11.5m wide on the house area and 55m long (inclusive of the back garden). There is approximately a 2m level difference between the ground levels to the front and rear of the property.

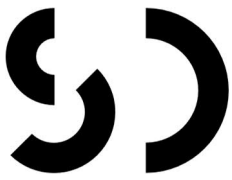


Figure 1: Site Location



2. Desk Basement Construction

The proposed methodology and construction sequence for constructing the basement are detailed in the following section and on drawings 1711-SDS-B1-S- 7000-7001 found in Appendix A. It is proposed to extend the existing lower ground floor to the rear under the full footprint of the house (including the new footprint of the rear extension). The new basement is proposed to be formed using a contiguous piled wall to the rear and underpinning the existing party wall, external loadbearing walls and existing shared garden wall down to formation level, with new walls built in 'pins'. The proposed underpins and piled wall will provide a vertical support to the existing / proposed superstructure above, maintaining the existing load path and will also have a retaining function, supporting the horizontal forces imposed by the soil pressure.

Due to the sloping ground level from the rear of the property to the front, the basement is globally unbalanced. It fully retains to the rear and has no retaining function to the front where the ground level sits at a reduced level. Borehole findings on site found the water table to be at approximately 1m BGL to the rear of the property. Hence the basement will be prone to sliding as there is little to no soil resistance at the front.

A contiguous piled wall will be installed to the rear face of the basement. The piled wall is to cantilever to prevent sliding from soil and water pressures and ensure global equilibrium is established. Once the piled wall has been constructed, the relatively impermeable clay will help to resist water ingress in the temporary construction case, whilst dewatering is carried out and a concrete liner wall is installed. The liner wall will resist the hydrostatic forces in the permanent case and be tied back to the contiguous piled wall so that the forces can be redistributed into the ground. The liner wall will also provide a solid surface for construction and waterproofing.

All global checks for equilibrium will be carried out for the basement system as a whole, before detailed retaining wall checks will be carried out for the individual side underpins' bearing pressures and rebar designs. Preliminary calculations to check initial equilibrium and strength checks for the basement's structural members can be found in Appendix C.

2.1. Basement Form, Construction and Load Path

2.1.1. Contiguous Piled Wall Construction

It is proposed to form the rear basement wall using a contiguous piled wall. This is to be installed from the existing patio level and designed to resist soil pressures during the temporary construction case, and soil and water pressures in the permanent case. In the temporary case, the clay will be relatively impermeable and will limit water ingress during the construction works.

Once the contiguous piled wall has been constructed, a capping beam will be constructed at ground level which will be laterally propped in the temporary case. The ground in front can then be excavated down to basement formation level. Dewatering in the temporary construction case will likely be required due to the high water table recorded in the borehole undertaken on site. All works are to be carried out by a competent contractor.

Once the basement slab is installed against the piles, a liner wall is to be cast in front of the piles - spanning between the basement slab and capping beam/ground slab above. This will resist water pressures in the permanent case in order to provide global equilibrium. The liner wall is to be fixed back to the contiguous piled wall so that the



hydrostatic forces can be transferred back into the piles, and resisted by the ground. Once water tightness and strength has been achieved, the rest of the basement construction works can be carried out.

2.1.2. Underpinning Construction

It is proposed to form the basement side walls with a combination of L-shaped reinforced concrete underpins. The reinforced underpins are to be cast in a typical 1-3-5-2-4 sequence to ensure stability of the masonry in the temporary case. The underpins are to be cast prior to the slab and propped across each other in the temporary case.

The underpinning is to be carefully sequenced to minimise the vertical and horizontal movement of the ground and structures, while the excavated pins are to be a maximum 1m wide to ensure the masonry above can arch sufficiently.

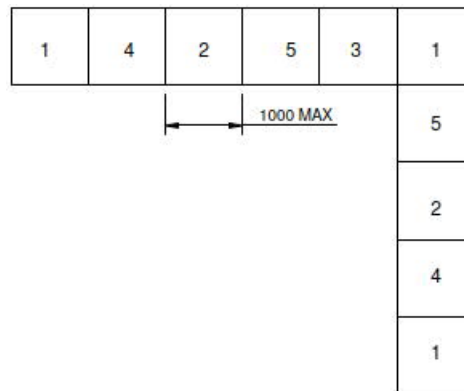


Figure 2: 1-3-5-2-4 Typical Underpinning Sequence

In the permanent case, the reinforced concrete walls will support the vertical loads from the superstructure above, as well as resisting the lateral loads applied behind the wall from the earth, surcharge loads, and water pressure that may occur. All reinforced concrete walls are designed as cantilevers.

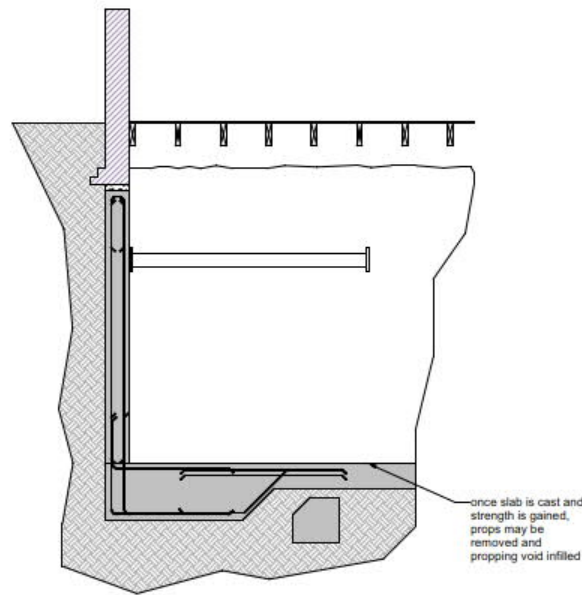


Figure 3: Typical RC Section

All underpins are to be cast prior to the construction of the concrete basement floor slab, so that the base of the walls can be propped off each other in accordance with the attached sequence of construction (found in Appendix A). Once the floor slab is cast and sufficient strength is gained, all temporary propping can be struck.

2.2. Basement Slab & Heave Protection

Given the depth of excavation and the underlying clay, there is the likelihood that the clay will heave with the relaxation of the load due to the removal of soil. As such, the slab is to be designed as suspended, spanning between thickenings acting as foundations. Heave protection to the underside of the slab will allow the heave to occur to limit additional stress to the slab.

Due to the water found on site, the basement will need to be designed to accommodate uplift from buoyancy in the permanent case. To counteract this uplift force, the basement slab will be suspended between party walls, internal tension piles and the rear piled wall. Preliminary calculations to verify the viability of the scheme designed this way can be found in Appendix C.

2.3. Ground Bearing Pressures

Site specific investigation has been undertaken by Maund Geo-Consulting LTD and according to their findings the existing soil is suitable for shallow foundations. For the basement foundations, spread foundations are suitable and a bearing pressure of 125-150kN/m² can be considered for design purposes.



2.4. Contamination

From the investigation works and laboratory testing, no significant contamination has been identified. See document *MGC-132-B/A-V1* produced by Maund Geo-Consulting LTD for all required measurements.

2.5. Waterproofing

The borehole undertaken by Maund Geo-Consulting found groundwater approximately 1m BGL to the rear of the property. The basement in the permanent case is to be suitably waterproofed with a two-system solution, provided by an integral solution such as waterproof concrete or internal tanking, as well as a secondary measure such as a cavity drain.



3. Superstructure

Below is an overview of the principles of the design for the superstructure. Preliminary structural drawings are provided in Appendix B.

3.1. Vertical Loading

Where existing walls and support to existing floor joists are to be removed in the property, new steel or timber beams (dependent on the wall construction and size) will be specified to reinstate this support. Where possible, beams will be supported on padstones on the existing walls, but where forces on the masonry are beyond the acceptable limits, steel columns are used.

3.2. Stability

Where a large section of masonry wall has been removed to the existing rear elevation of the main portion of the property, a steel frame will be installed to reinstate the lateral stability.

When designing the stability frame, lateral wind loads are calculated assuming the adjacent building was at some time removed (as required by the building regulations). Sheltering from the remaining building has been considered.

Columns are designed to be restrained in plane by the incoming steel beams. Out of plane restraint is achieved by fixing columns into the adjacent masonry walls, or where applicable via stiff connections to the floor. In all instances, the steels are to be appropriately tied into the floor and walls to ensure that they act as a diaphragm and transfer loads into the frame.

3.3. Steel Supporting Masonry Walls

New beams supporting existing masonry walls and new cavity walls are designed to limit deflection to $\text{span}/500$ or 10mm whichever is less. Where secondary beams are supported on primary beams the compound deflection is checked to ensure this limit is not reached.

3.4. Padstones

Stresses below beams supported on masonry walls are checked both directly under the beam, to determine the requirements for padstones, and the walls are also checked globally. Local stresses for brickwork are limited to typically agreed limits of $0.42\text{N/mm}^2 \times 1.5$ local enhance factor $\times 1.5$ FoS (as designing to limit state) $= 1\text{ N/mm}^2$. This is different for new brickwork and the allowable stress limits are given in individual calculations.

3.5. Disproportionate Collapse

The property is a 4 storey single occupancy residential property and so falls into consequence class 1. Hence, no additional measures are required.

3.6. Design Codes Used

All calculations have been carried to the requirements of the current building regulations and Eurocode standards.



4. Designer Response to Investigations

This section notes how the proposed designs discussed in the preceding sections respond to the findings of the site survey and desk study undertaken.

4.1. Ground Conditions and Ground Water

The desk study and borehole undertaken on site showed that the basement will be constructed in the Claygate Member, comprised of silty fine sandy clay. As such, there is a risk of heave due to the de-loading of the soil. Hence, the slab will be designed as suspended with suitable heave protection.

The footings will be designed as thickenings to the edge of the slab and be ground bearing as the weight of the concrete and retaining wall will reinstate the weight of soil removed, meaning heave will not affect the footings.

Within the borehole to the rear of the proposed basement, water was recorded at approximately 1m BGL. As this is above ground level to the front of the property, it is unlikely that this is the ground water level under the entirety of the property, but it cannot be confirmed whether this water is merely perched. Hence all retaining members will be designed in the permanent case for this water level, and fully retaining water to ground level in the accidental case.

Due to the potential high water table, considerations for dewatering of the site during construction will be carried out.

The structural members will also be suitably sized to resist the possible uplift forces of any water pressure acting on the slab. The basement slab acts as suspended between party walls, internal tension piles, and the rear piled wall. The weight of the existing and proposed members will be accounted for when designing for the net uplift force. Where the load being transferred downwards is not sufficient to resist the uplift force, the slab and thickenings will be designed to span onto the internal piles and back piled wall to ensure the distribution back to the piles and the piles will be designed for the net uplift force with a tension force to ensure equilibrium.

4.2. Existing Trees and Infrastructure

To the front and rear of the property there are trees of significant size. To the front of the property, there is a tree of approximately 20m in height. However, this is approximately 18m away from the nearest part of the proposed basement. To the rear of the property the closest tree is approximately 9m from the rear of the proposed basement. However, this tree is approximately only 4m in height. Hence both are assumed to be outside any root protection zones.

No works are proposed to take place adjacent to existing infrastructure or highways and therefore an AIP will not be required.

4.3. Drainage

A full CCTV is recommended to be carried out to confirm the details of the existing drainage system.

A provision will be made for a surface water pump for drainage to the proposed bathroom and utilities within the basement. If possible, the drainage will be kept to a gravity system if the existing levels in the private / public realm allow for it in order to reduce maintenance requirements.



All other drainage will remain gravity based and connect into the existing system, renewing where necessary if the system is found to be not in a good state of repair. This will outfall into the existing sewer in the road.

If any sewers are found to be public (serving two or more properties), and it is proposed to build within 3m or over these, a build over agreement with Thames Water will be required.

4.4. Flooding

The desk study confirmed that there is a low risk of flooding on site. The works are not considered to have an impact on local flooding.

4.5. Ground Movement and Damage Assessment to Adjacent Properties

During the project, it is critical to ensure that the works undertaken do not cause undue levels of vertical and horizontal movement to adjacent structures.

The majority of the basement is to be formed using underpinning to the existing footings and masonry walls. To limit movement, this will be carried out in the sequence as shown indicatively on SD Engineers' drawings. As previously stated, no underpin will be greater than 1m in width to ensure the masonry above can arch suitably in the temporary case. The rear of excavations must not be left unsupported when the site is unattended. No adjacent sections of underpinning will be excavated within 48 hours of each other.

In some areas, if the pins are greater than 1m below the existing foundation level, transition pins may be required to avoid any hard spots that can cause differential settlements issues in the future.

Each underpin will be the full width of the existing wall above. Underpins are to be dry packed up tight to the underside of the existing masonry 48 hours after pouring.

Due to the proposed basement underpinning the neighbouring property's party wall, an assessment has been carried out on the predicted ground movements that could be expected during the works and the impact this would have on the neighbouring property. The findings from this assessment can be found in Maund Geo-Consulting LTD's document *MGC-132-BIA-V1*.

To ensure best practice, a competent contractor experienced in basement construction, must be appointed. The Contractor will be required to design any temporary works to comply with BS5975:2019 Code of Practice for Temporary Works.

4.6. CDM

Method statements are required from the contractor for the following;

- Creating openings greater than 3m in existing walls
- Underpinning of existing footings
- Construction of the RC retaining wall
- Construction of the basement retaining wall

Suggested sequences are provided for the;

- Construction of the basement retaining wall



5. Construction monitoring

5.1. Movement

Construction monitoring will be required to ensure that there is no sudden or unexpected movement of any walls during construction of the basement. The following suggested monitoring procedure is intended as an indicative guidance document to establish a base level for monitoring. All items noted must be confirmed a specialist monitoring contractor.

5.2. Monitoring Required

It is advised that to aid in the assessment of movement during construction, the following items are included:

- Schedules of condition at the neighbouring property prior to commencement of works and upon completion
- Visual inspections of the walls being underpinned at regular intervals
- Vertical monitoring measurements
- Horizontal monitoring methods

These will aid in ensuring that no excessive movement takes place while acting as an early warning indicator to mitigate any damage.

5.3. Methods of Monitoring

Methods of monitoring can include but are not limited to:

- General visual surveys
- Cracking to party walls - Tell-Tails on any existing cracks
- Settlement monitoring – use of levelling equipment and targets
- Lateral monitoring – measurement of distance between external wall with targets/ relative differences between walls

The number and positioning of targets should be agreed between the contractor and monitoring specialist to ensure appropriate numbers are maintained at all times.

5.4. Structural Monitoring

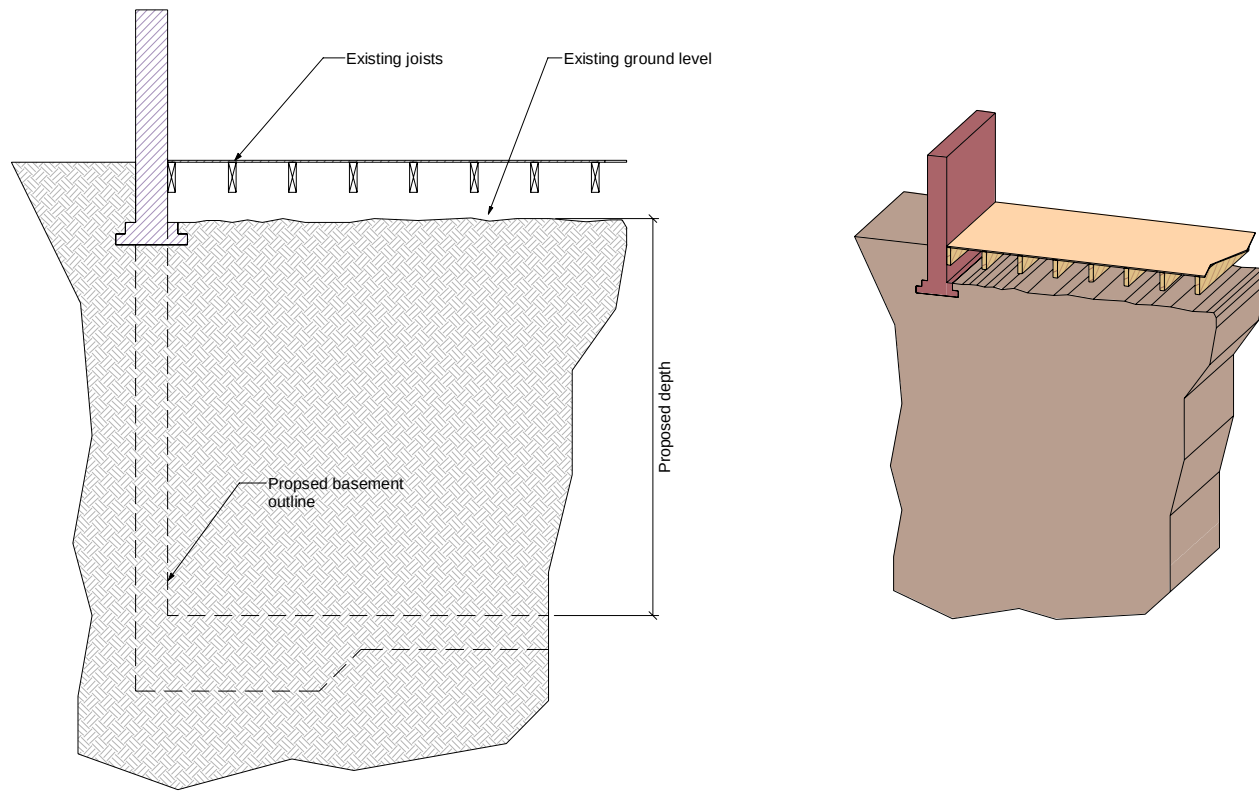
Further to the monitoring of movement, the construction of the basement should be monitored by an appropriate person at key stages.

Key stages at this stage are considered as:

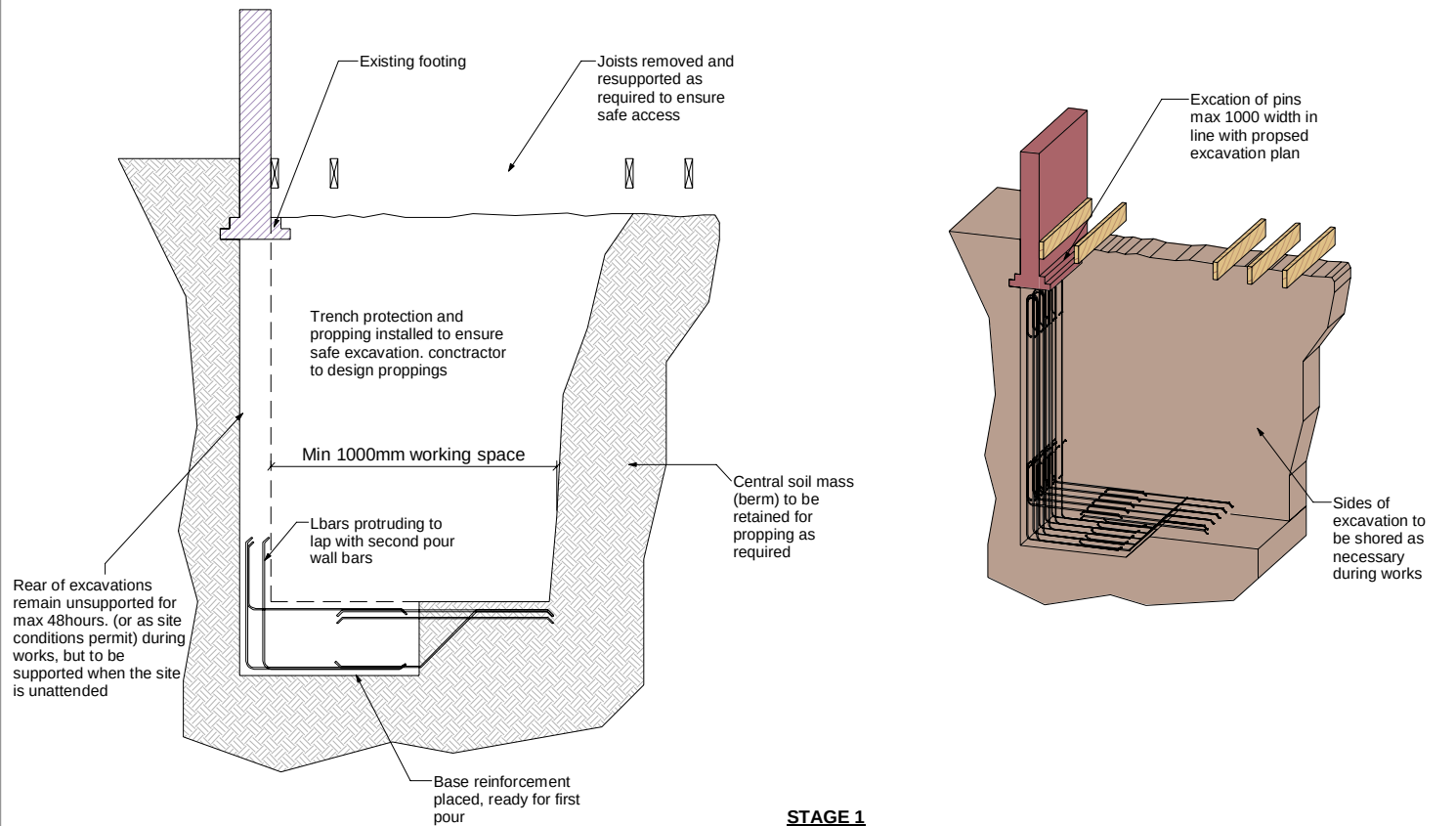
- Excavation of first underpin
- First L-shaped RC underpin pour
- Prior to pouring of floor slab



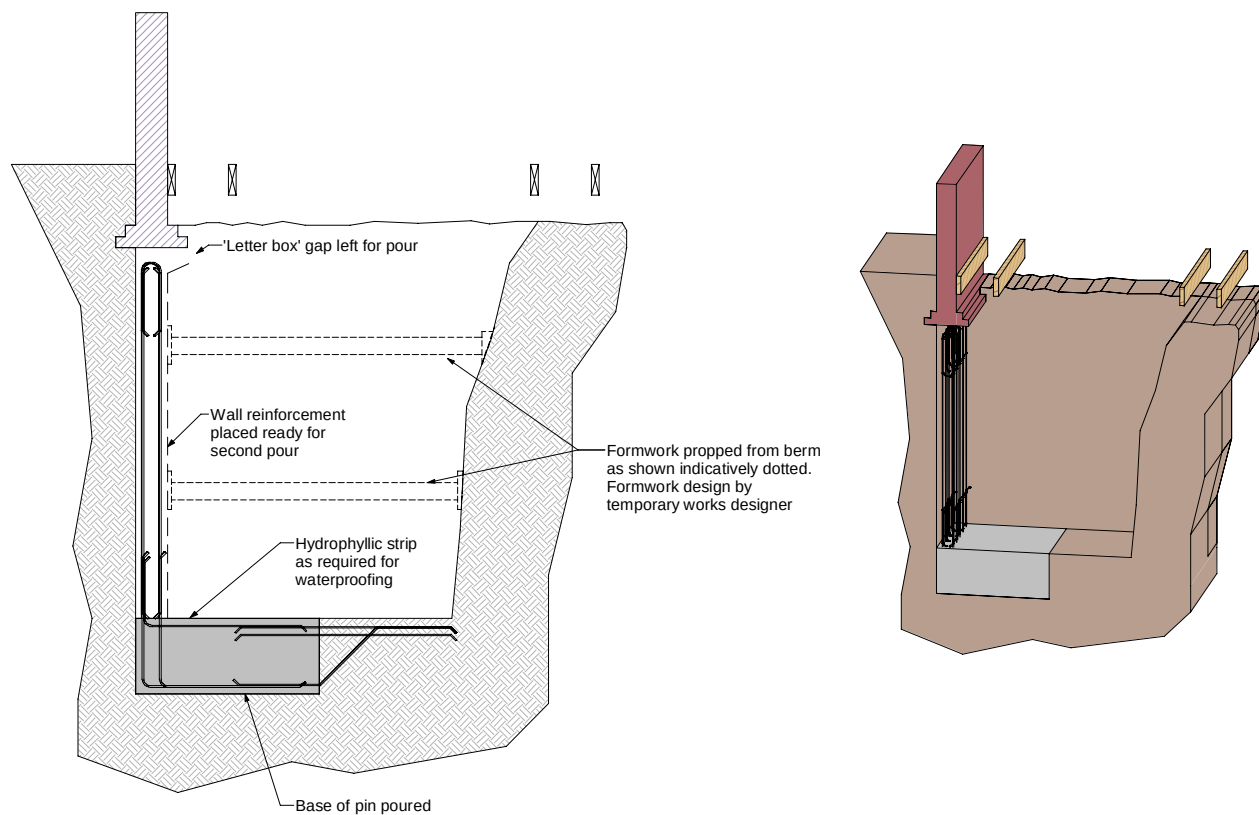
Appendix A - Basement Sequence



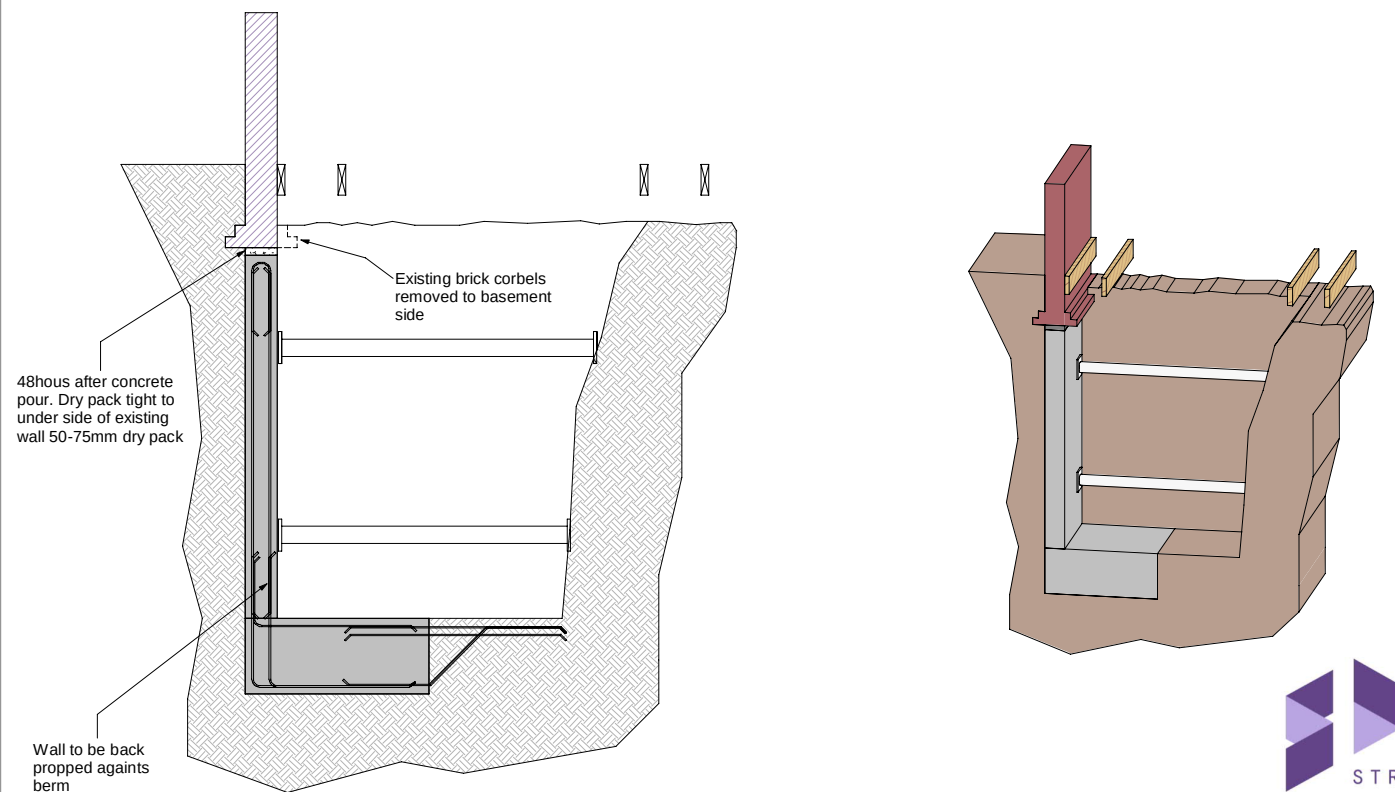
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STAGE 1
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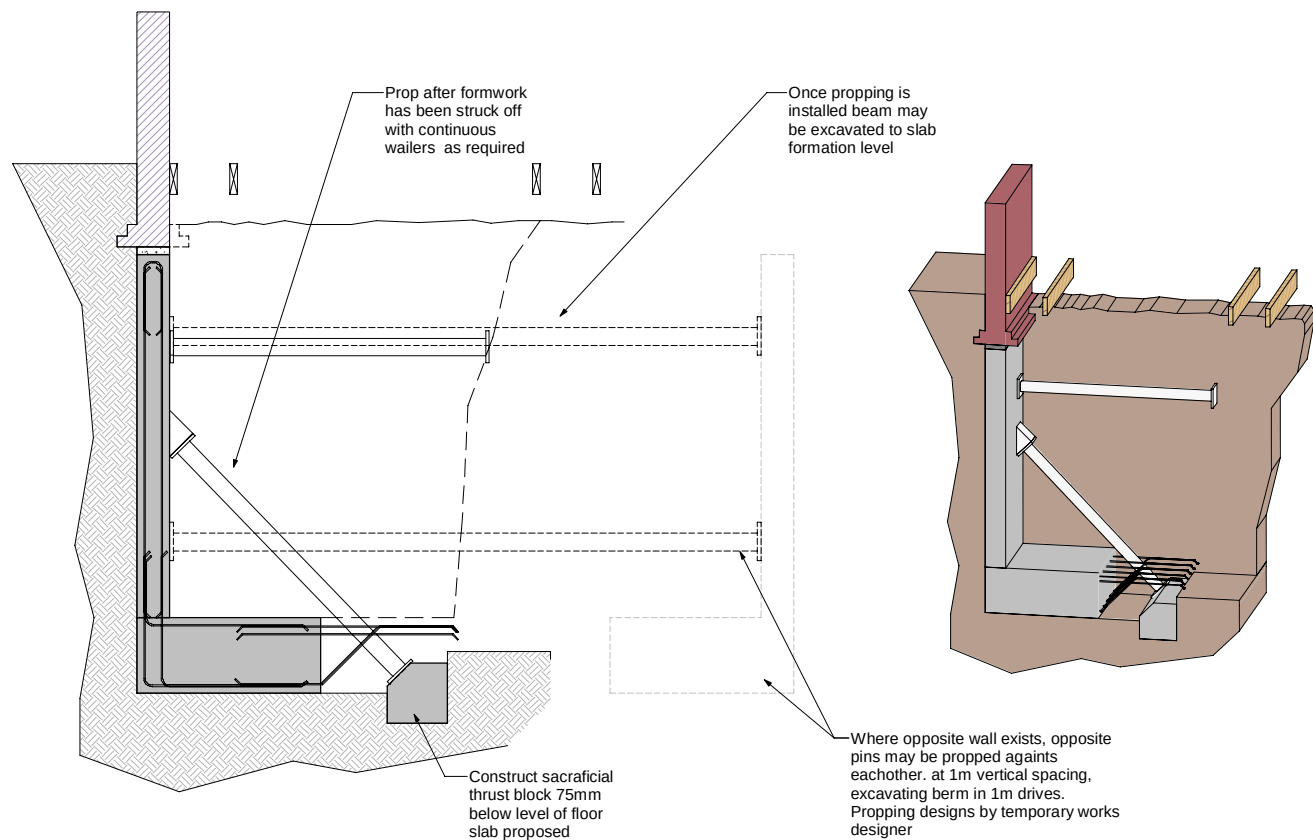


STAGE 2
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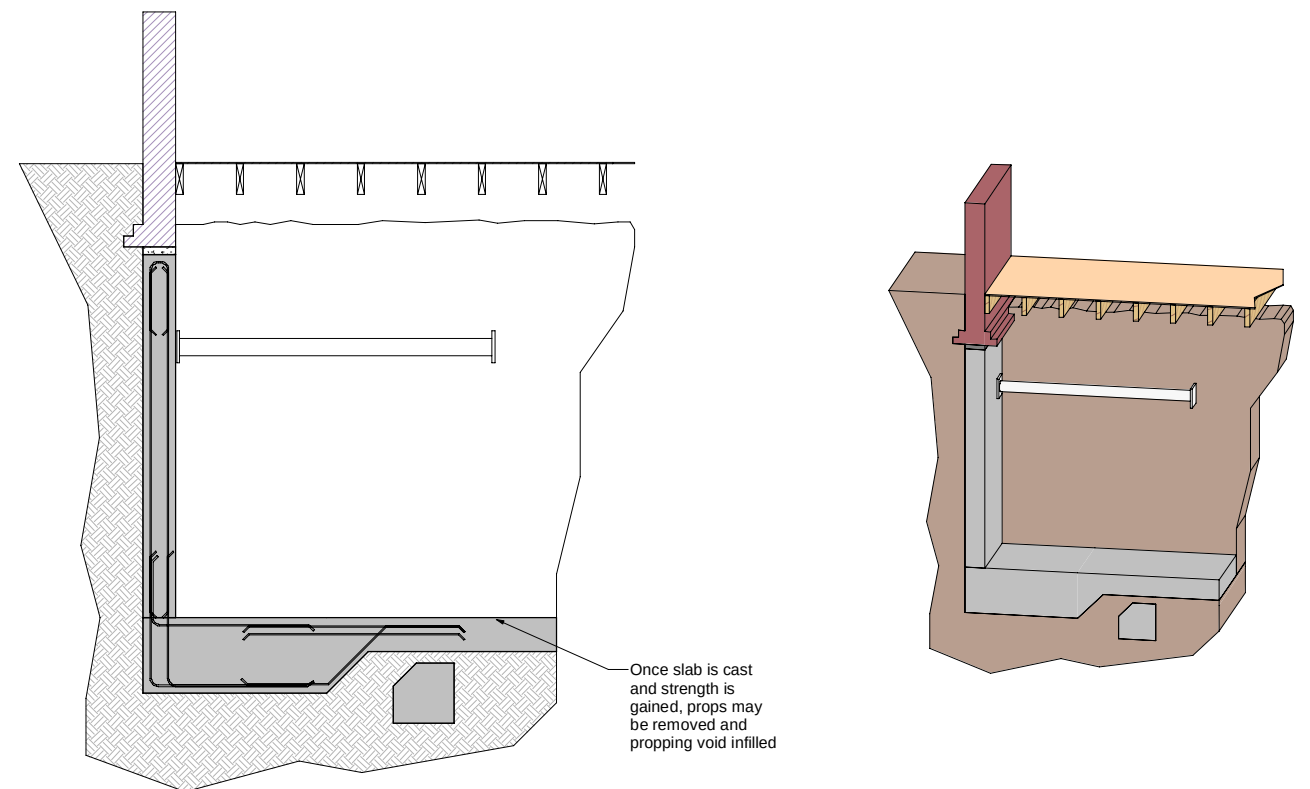


STAGE 3
NOT TO SCALE

Drawings should read
in conjunction with
the BIA report submit-
ted to planning



STAGE 4
NOT TO SCALE



STAGE 5
NOT TO SCALE

Drawings should read
in conjunction with
the BIA report submit-
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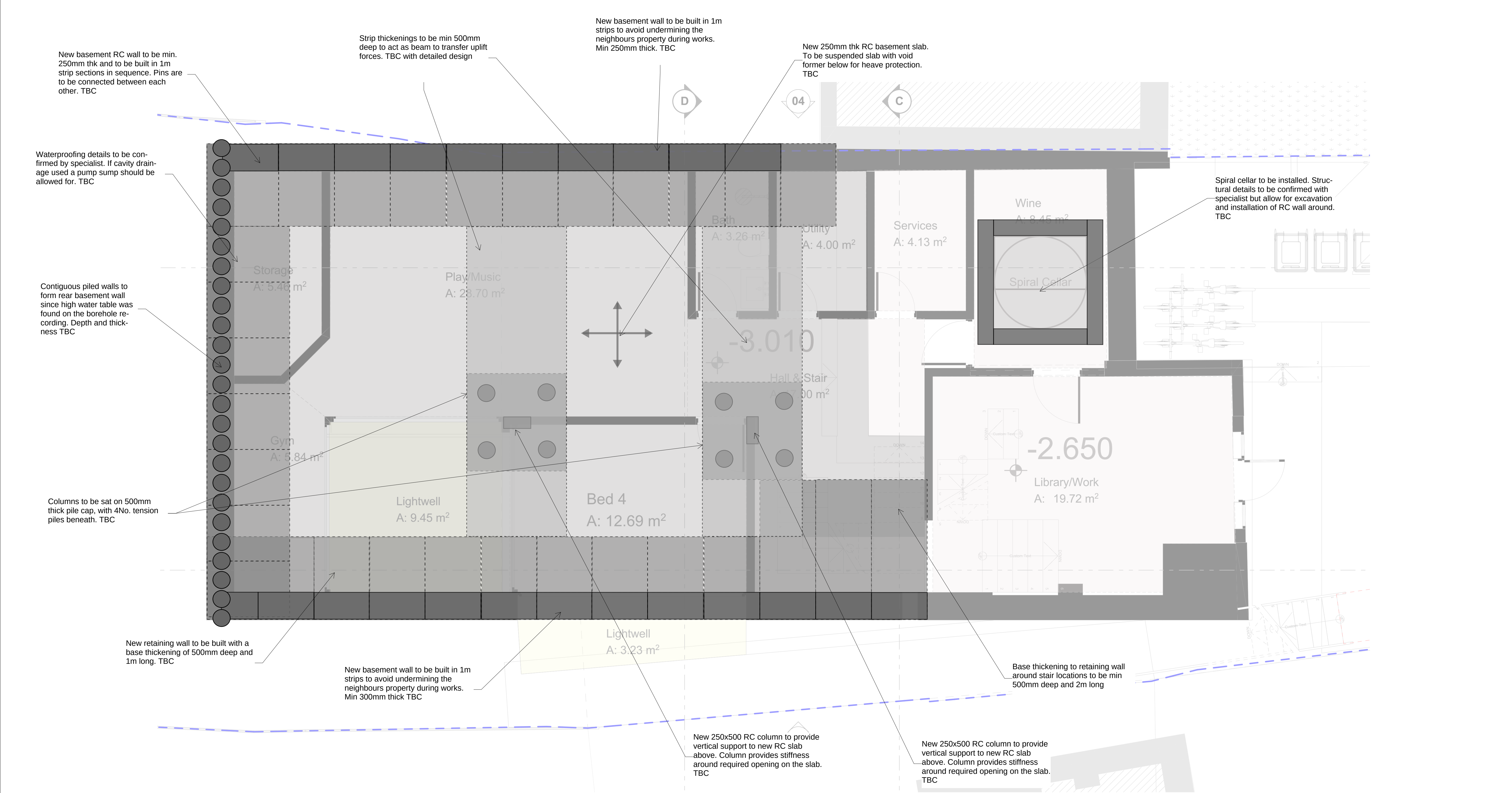


PRELIMINARY

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SDS1711
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Construction Sequences
Sheet 2



Appendix B - Preliminary Structural Drawings

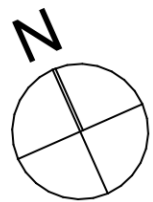


Basement Floor Plan
1:50

- Notes:
- These drawings are not to be used for setting out purposes. Refer to the latest Architects information and site measure as required.
 - Contact SD Structures in the event of any discrepancies between findings on site and these drawings.
 - Drawing is to be read in conjunction with the SD Structures Engineer's Specification and General Notes.
 - 3D views are indicative only and any conflicting 2D information should take precedence. If in doubt contact SD Structures prior to starting work

KEY					
	Existing	Concrete	Steel	Timber	Masonry
Beams	Ex beam				
Column / pier					
Wall					
Column / wall below					
Slab/floor	Ex				

KEY CONT'D	
	Foundation below
ps	Padstone
	Lintel above
DJ / TJ	Double / triple joist
⌵	Crank point
⌵	Lateral restraint strap

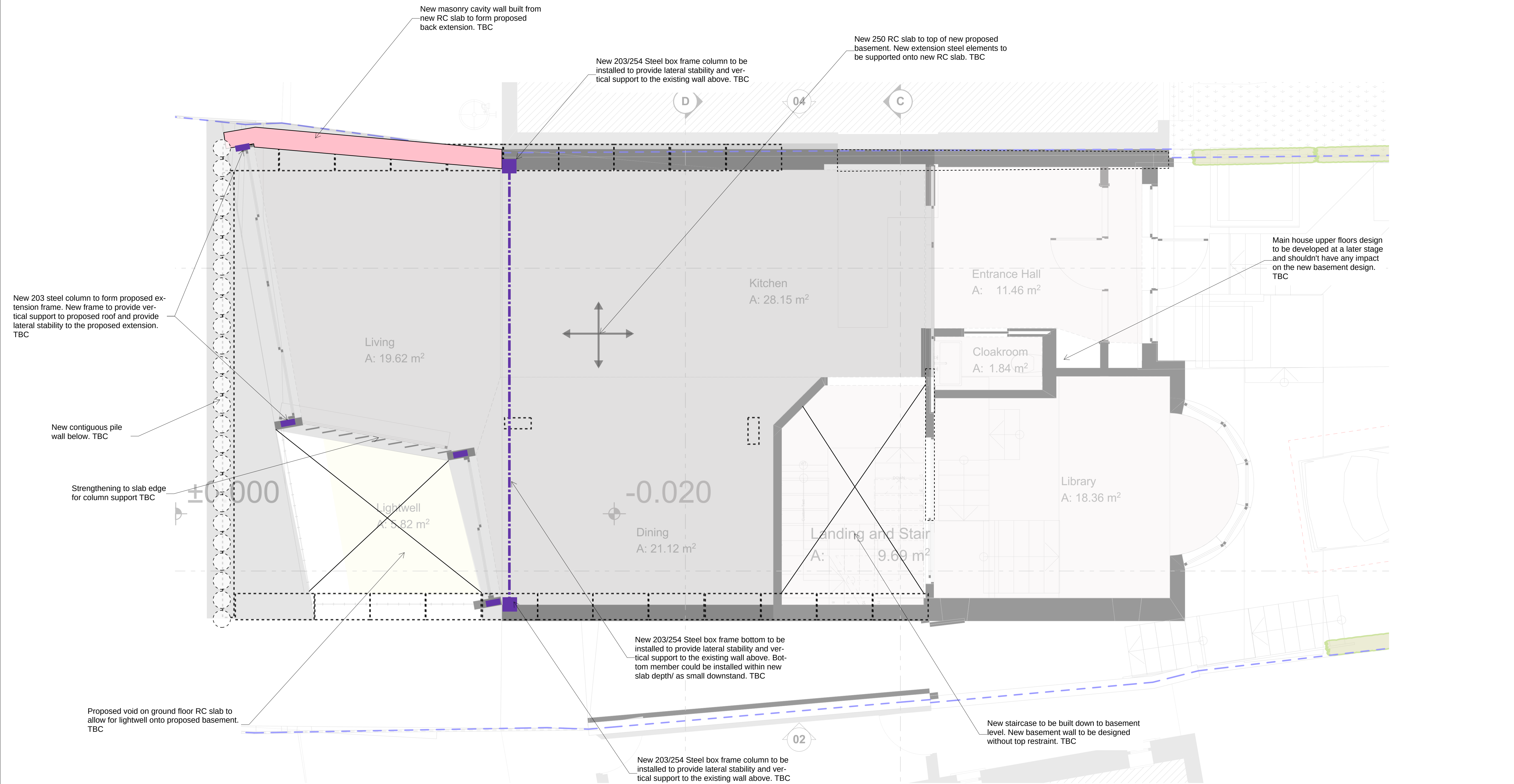


Hazards noted thus

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Rev	Amendment	Date	Drawn	Eng	@A1

SD Structures	
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S1 Suitable for Coordination	
45 Chomeley Crescent 1711	
Eng: MF	
Drawn: MF	
Basement Floor Plan	
Proj Orig Lev Rol No Status Rev	
1711 - SDS-B1-S-2000 S1 P02	

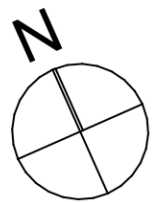


Ground Floor Plan
1:50

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Beams	Ex beam				
Column / pier					
Wall					
Column / wall below					
Slab/floor	Ex				

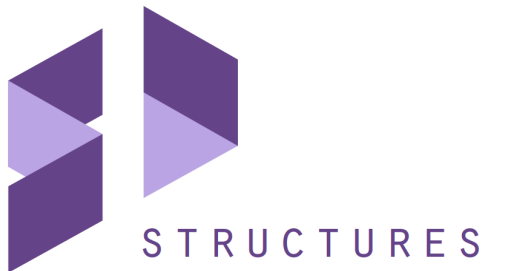
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	Lintel above
DJ / TJ	Double / triple joist
CP	Crank point
	Lateral restraint strap



Hazards noted thus

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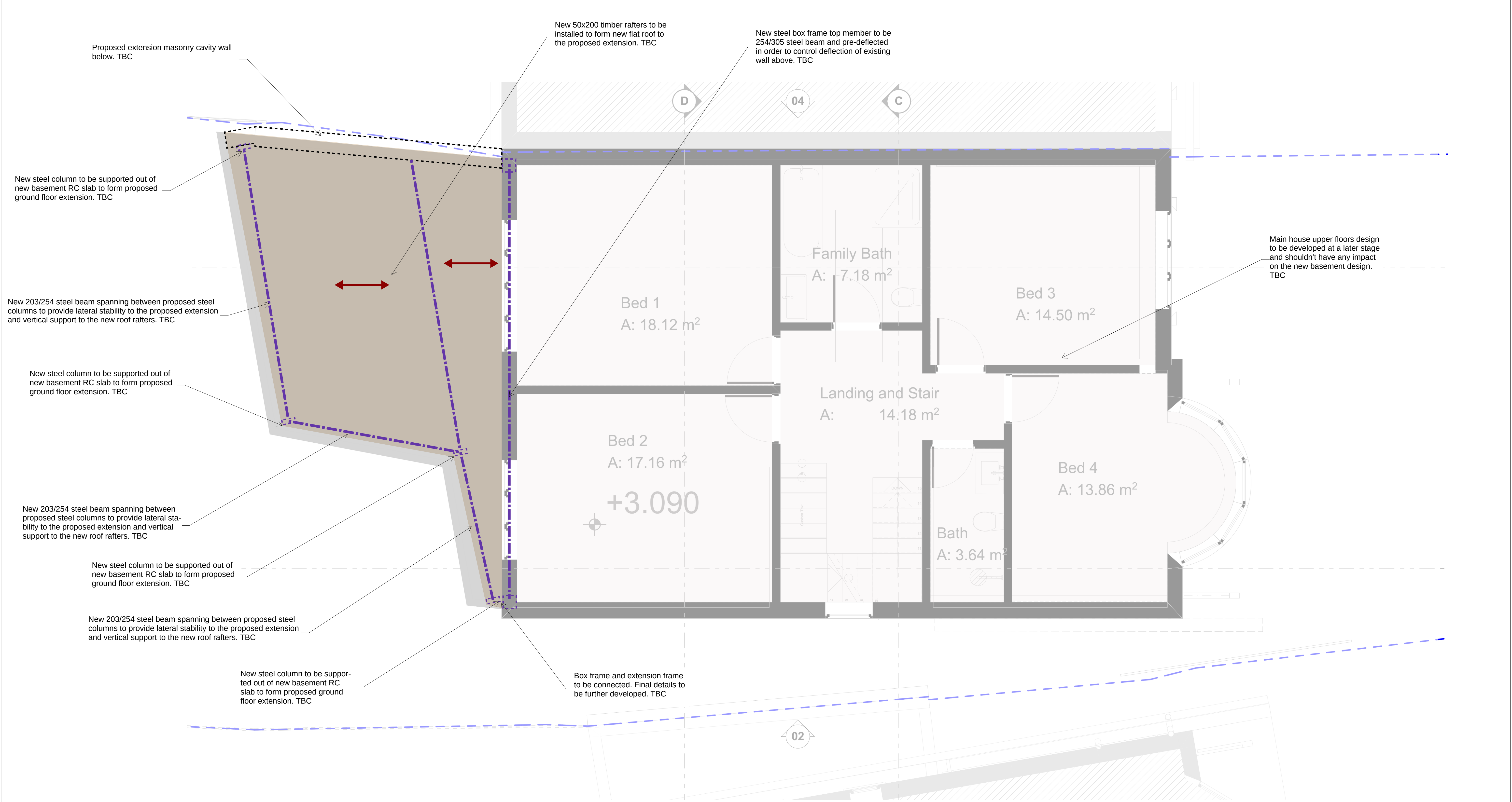


S1 Suitable for Coordination

45 Chomeley Crescent
1711

Eng: MF
Drawn: MF

Ground Floor Plan

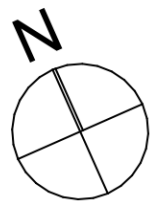


First Floor Plan
1:50

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Column / pier					
Wall					
Column / wall below					
Slab/floor	Ex				

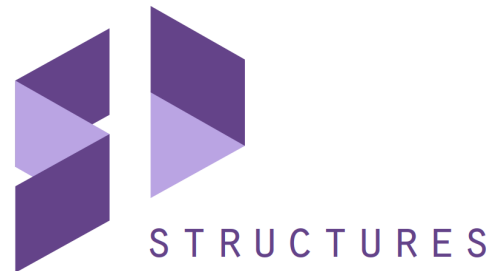
KEY CONT'D	
	Foundation below
ps	Padstone
	Lintel above
DJ / TJ	Double / triple joist
CP	Crank point
	Lateral restraint strap



Hazards noted thus

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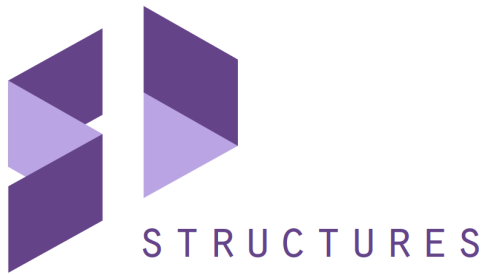


S1 Suitable for Coordination

45 Chomeley Crescent

1711

First Floor Plan



New steel box frame top member to be 254/305 steel beam and pre-deflected in order to control deflection of existing wall above. TBC

New 250 RC slab to top of new proposed basement. New extension steel elements to be supported onto new RC slab. TBC

New 250x500 RC column to provide vertical support to new RC slab above. TBC

Contiguous piled walls to form rear basement wall since high water table was found on the borehole recording. Depth and thickness TBC

Waterproofing details to be confirmed by specialist. If cavity drainage used a pump sump should be allowed for. TBC

Slab to have base thickening 500mm deep and 1m long. To be dowelled into piled wall. TBC

New 250mm thk RC basement slab. To be suspended slab with void former below for heave protection. TBC

Column to be sat on 500mm thick pile cap, with 4No. tension piles beneath (in 2x2 layout). TBC

Main house upper floors design to be developed at a later stage and shouldn't have any impact on the new basement design. TBC

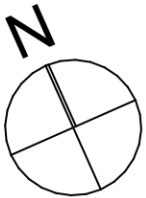
New 250x500 RC column to provide vertical support to new RC slab above. Column provides stiffness around required opening on the slab. TBC

Section 1:50

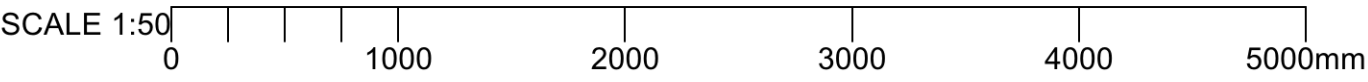
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KEY					
	Existing	Concrete	Steel	Timber	Masonry
Beams	Ex beam				
Column / pier					
Wall					
Column / wall below					
Slab/floor	Ex				

KEY CONT'D	
	Foundation below
ps	Padstone
	Lintel above
DJ / TJ	Double / triple joist
⌂	Crank point
⌂	Lateral restraint strap



Hazards noted thus



P02	Issued for Coordination	21/07/2023	MF	MF	As indicated
Rev	Amendment	Date	Drawn	Eng	Scale: @A1

S1 Suitable for Coordination						
45 Chomeley Crescent 1711					Eng: MF Drawn: MF	
First Floor Plan						
Proj	Orig	Lev	Rev	No	Status	Rev
1711 - SDS-GF-S-2002					S1	P02



Appendix C - Preliminary Calculations

250mm thick retaining wall preliminary calculation

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.15

Retaining wall details

Stem type Propped cantilever
Stem height $h_{\text{stem}} = 2700$ mm
Prop height $h_{\text{prop}} = 2700$ mm
Stem thickness $t_{\text{stem}} = 250$ mm
Angle to rear face of stem $\alpha = 90$ deg
Stem density $\gamma_{\text{stem}} = 25$ kN/m³
Toe length $l_{\text{toe}} = 1000$ mm
Base thickness $t_{\text{base}} = 500$ mm
Base density $\gamma_{\text{base}} = 25$ kN/m³
Height of retained soil $h_{\text{ret}} = 2700$ mm Angle of soil surface $\beta = 0$ deg
Depth of cover $d_{\text{cover}} = 0$ mm
Height of water $h_{\text{water}} = 1700$ mm
Water density $\gamma_w = 9.8$ kN/m³

Retained soil properties

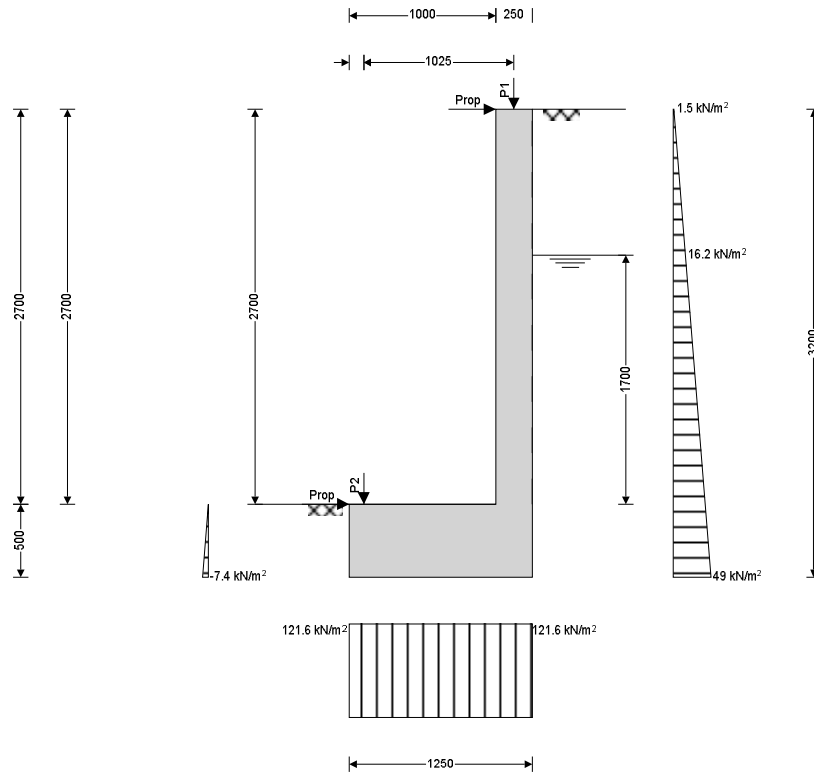
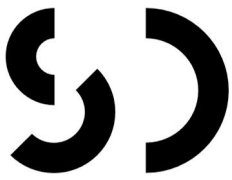
Soil type Organic silty clay
Moist density $\gamma_{\text{mr}} = 15$ kN/m³
Saturated density $\gamma_{\text{sr}} = 15$ kN/m³
Characteristic effective shear resistance angle $\phi'_{r,k} = 22$ deg
Characteristic wall friction angle $\delta_{r,k} = 11$ deg

Base soil properties

Soil type Organic silty clay
Soil density $\gamma_b = 15$ kN/m³
Characteristic effective shear resistance angle $\phi'_{b,k} = 22$ deg
Characteristic wall friction angle $\delta_{b,k} = 11$ deg
Characteristic base friction angle $\delta_{bb,k} = 14.7$ deg
Presumed bearing capacity $P_{\text{bearing}} = 150$ kN/m²

Loading details

Variable surcharge load Surcharge_Q = 1.5 kN/m²
Vertical line load at 1125 mm $P_{G1} = 86.7$ kN/m
 $P_{Q1} = 21.7$ kN/m
Vertical line load at 100 mm $P_{G2} = 9.1$ kN/m
 $P_{Q2} = 2.1$ kN/m



General arrangement - sketch pressures relate to bearing check

Calculate retaining wall geometry

Base length $l_{base} = 1250$ mm

Saturated soil height $h_{sat} = 1700$ mm

Moist soil height $h_{moist} = 1000$ mm

Length of surcharge load $l_{sur} = 0$ mm

Vertical distance $x_{sur_v} = 1250$ mm

Effective height of wall $h_{eff} = 3200$ mm

Horizontal distance $x_{sur_h} = 1600$ mm

Area of wall stem $A_{stem} = 0.675$ m² Vertical distance $x_{stem} = 1125$ mm

Area of wall base $A_{base} = 0.625$ m² Vertical distance $x_{base} = 625$ mm

For undrained soils - Annex C.1(2)

Active pressure coefficient $K_A = 1.000$

Passive pressure coefficient

$K_P = 1.000$

Bearing pressure check

Vertical forces on wall

Total $F_{total_v} = F_{stem} + F_{base} + F_{P_v} + F_{water_v} = 152$ kN/m

Horizontal forces on wall

Total $F_{total_h} = F_{sur_h} + F_{sat_h} + F_{water_h} + F_{moist_h} + F_{pass_h} = 78.7$ kN/m

Moments on wall

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = 63.4$ kNm/m

Check bearing pressure

Propping force to stem $F_{prop_stem} = 9.9$ kN/m Propping force to base $F_{prop_base} = 68.8$ kN/m

Bearing pressure at toe $q_{toe} = 121.6$ kN/m² Bearing pressure at heel $q_{heel} = 121.6$ kN/m²

Factor of safety $FoS_{bp} = 1.234$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

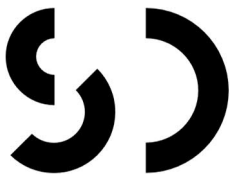
In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.15

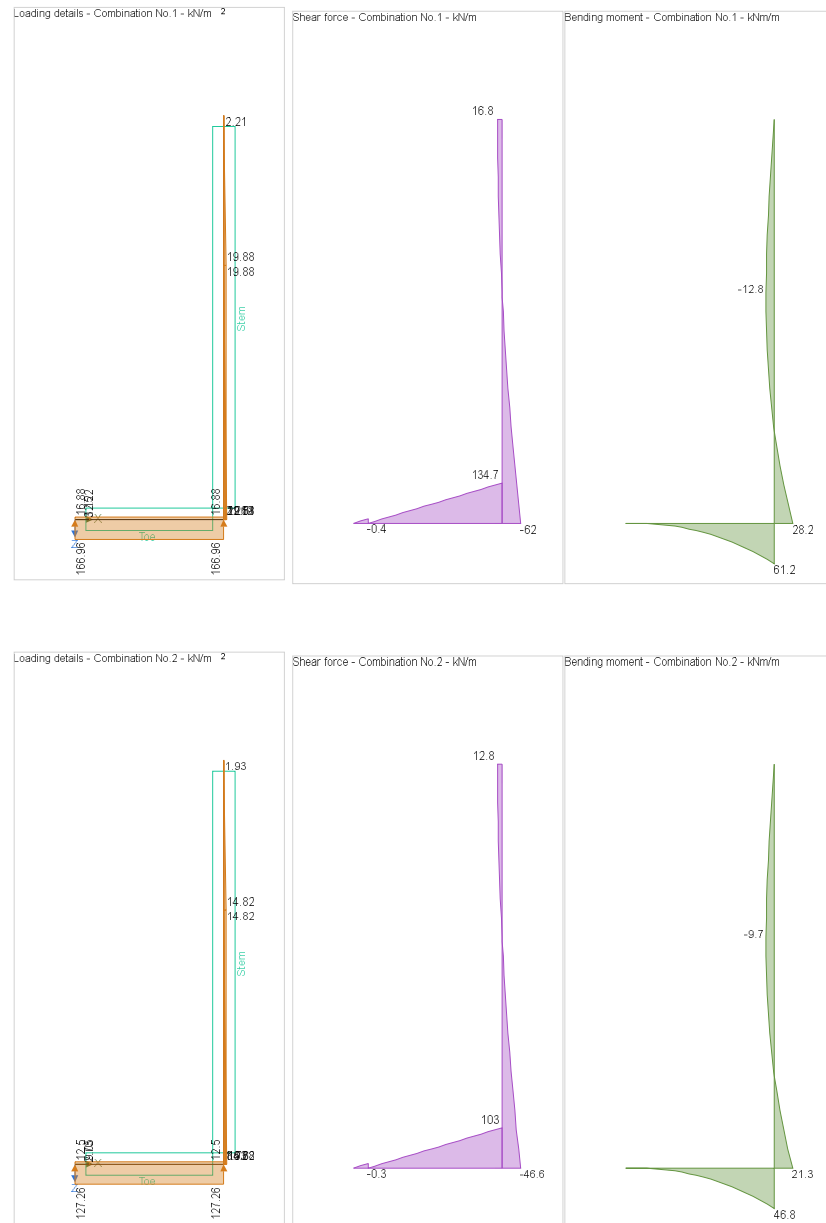
Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class C30/37

Char.comp.cylinder strength $f_{ck} = 30$ N/mm² Mean axial tensile strength $f_{ctm} = 2.9$ N/mm²



Secant modulus of elasticity $E_{cm} = 32837 \text{ N/mm}^2$ Maximum aggregate size $h_{agg} = 20 \text{ mm}$
 Design comp.concrete strength $f_{cd} = 17.0 \text{ N/mm}^2$ Partial factor $\gamma_C = 1.50$
Reinforcement details
 Characteristic yield strength $f_{yk} = 500 \text{ N/mm}^2$ Modulus of elasticity $E_s = 200000 \text{ N/mm}^2$
 Design yield strength $f_{yd} = 435 \text{ N/mm}^2$ Partial factor $\gamma_S = 1.15$
Cover to reinforcement
 Front face of stem $c_{sf} = 40 \text{ mm}$ Rear face of stem $c_{sr} = 50 \text{ mm}$
 Top face of base $c_{bt} = 50 \text{ mm}$ Bottom face of base $c_{bb} = 75 \text{ mm}$



Check stem design at 1258 mm

Depth of section $h = 250 \text{ mm}$

Rectangular section in flexure - Section 6.1

Design bending moment $M = 12.8 \text{ kNm/m}$ $K = 0.011$ $K' = 0.207$

$K' > K$ - No compression reinforcement is required

Tens.reinforcement required $A_{sfM.req} = 159 \text{ mm}^2/\text{m}$

Tens.reinforcement provided 10 dia.bars @ 200 c/c

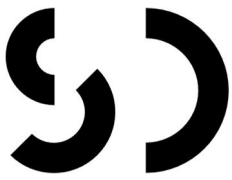
Tens.reinforcement provided

$A_{sfM.prov} = 393 \text{ mm}^2/\text{m}$

Min.area of reinforcement $A_{sfM.min} = 294 \text{ mm}^2/\text{m}$

Max.area of reinforcement $A_{sfM.max} = 10000 \text{ mm}^2/\text{m}$

PASS - Area of reinforcement provided is greater than area of reinforcement required



Library item: Rectangular single summary

Deflection control - Section 7.4

Limiting span to depth ratio 40 Actual span to depth ratio 13.8

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width $w_{max} = 0.3$ mm Maximum crack width $w_k = 0.173$ mm

PASS - Maximum crack width is less than limiting crack width Check stem design at base of stem

Depth of section $h = 250$ mm

Rectangular section in flexure - Section 6.1

Design bending moment $M = 28.2$ kNm/m $K = 0.025$ $K' = 0.207$

$K' > K$ - No compression reinforcement is required

Tens.reinforcement required $A_{sr.req} = 352$ mm²/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided

$A_{sr.prov} = 565$ mm²/m

Min.area of reinforcement $A_{sr.min} = 292$ mm²/m Max.area of reinforcement $A_{sr.max} = 10000$ mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single summary

Deflection control - Section 7.4

Limiting span to depth ratio 40 Actual span to depth ratio 13.9

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width $w_{max} = 0.3$ mm Maximum crack width $w_k = 0.257$ mm

PASS - Maximum crack width is less than limiting crack width Rectangular section in shear - Section 6.2

Design shear force $V = 62$ kN/m

Rectangular section in shear - Section 6.2

Design shear force $V = 62$ kN/m Design shear resistance $V_{Rd.c} = 105.2$ kN/m

PASS - Design shear resistance exceeds design shear force

Check stem design at prop

Depth of section $h = 250$ mm

Rectangular section in shear - Section 6.2

Design shear force $V = 16.8$ kN/m

Rectangular section in shear - Section 6.2

Design shear force $V = 16.8$ kN/m Design shear resistance $V_{Rd.c} = 105.2$ kN/m

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Min.area of reinforcement $A_{sx.req} = 250$ mm²/m Max.spacing of reinforcement $S_{sx.max} = 400$ mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided

$A_{sx.prov} = 393$ mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section $h = 500$ mm

Rectangular section in flexure - Section 6.1

Design bending moment $M = 61.2$ kNm/m $K = 0.012$ $K' = 0.207$

$K' > K$ - No compression reinforcement is required

Tens.reinforcement required $A_{bb.req} = 355$ mm²/m

Tens.reinforcement provided 16 dia.bars @ 200 c/c Tens.reinforcement provided

$A_{bb.prov} = 1005$ mm²/m

Min.area of reinforcement $A_{bb.min} = 628$ mm²/m Max.area of reinforcement $A_{bb.max} = 20000$ mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single summary

Crack control - Section 7.3

Limiting crack width $w_{max} = 0.3$ mm Maximum crack width $w_k = 0.225$ mm

PASS - Maximum crack width is less than limiting crack width Rectangular section in shear - Section 6.2

Design shear force $V = 134.7$ kN/m

Rectangular section in shear - Section 6.2

Design shear force $V = 134.7$ kN/m Design shear resistance $V_{Rd.c} = 176$ kN/m

PASS - Design shear resistance exceeds design shear force

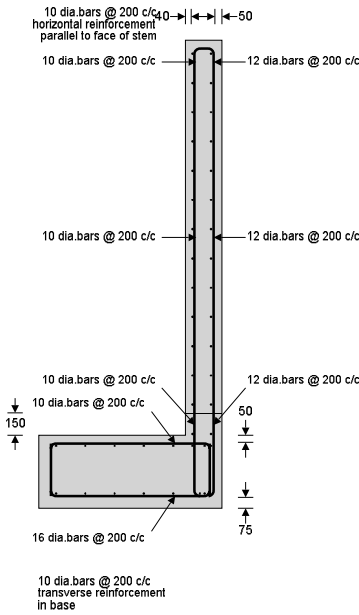
Secondary transverse reinforcement to base - Section 9.3

Min.area of reinforcement $A_{bx.req} = 201$ mm²/m Max.spacing of reinforcement $S_{bx.max} = 450$ mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided

$A_{bx.prov} = 393$ mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required



Reinforcement details

Passes all strength and equilibrium checks for permanent case (water 1m BGL) and accidental case (water at GL) .



300mm thick retaining wall preliminary calculation

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.15

Retaining wall details

Stem type Cantilever
Stem height $h_{\text{stem}} = 2700$ mm
Stem thickness $t_{\text{stem}} = 300$ mm
Angle to rear face of stem $\alpha = 90$ deg
Stem density $\gamma_{\text{stem}} = 25$ kN/m³
Toe length $l_{\text{toe}} = 2000$ mm
Base thickness $t_{\text{base}} = 500$ mm
Base density $\gamma_{\text{base}} = 25$ kN/m³
Height of retained soil $h_{\text{ret}} = 2700$ mm Angle of soil surface $\beta = 0$ deg
Depth of cover $d_{\text{cover}} = 0$ mm
Height of water $h_{\text{water}} = 1700$ mm
Water density $\gamma_w = 9.8$ kN/m³

Retained soil properties

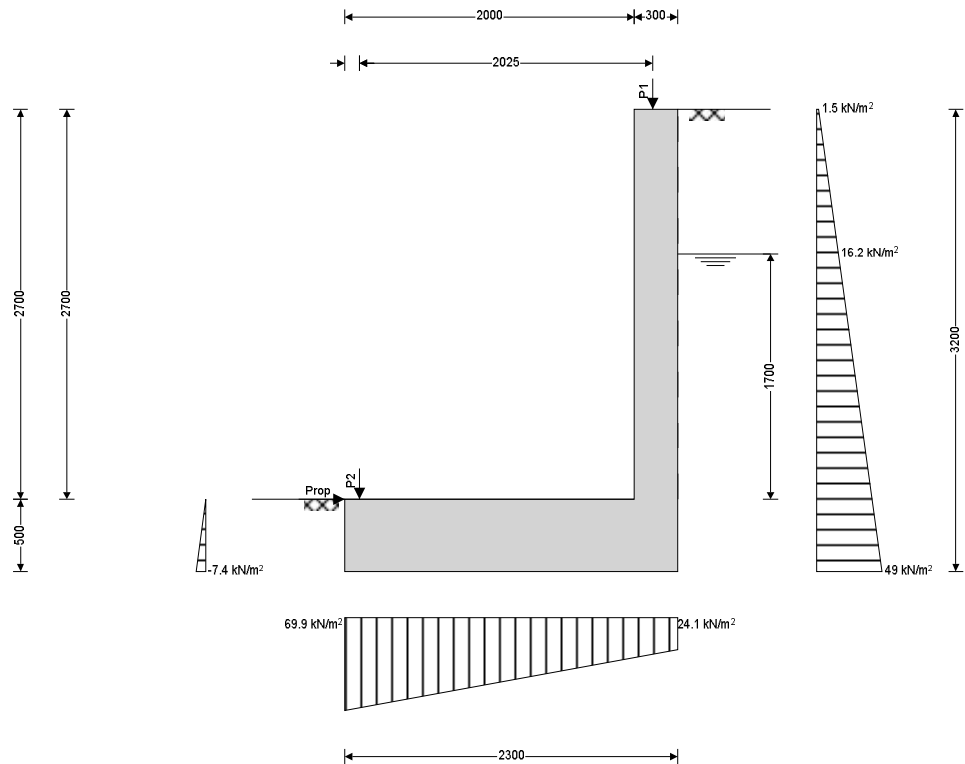
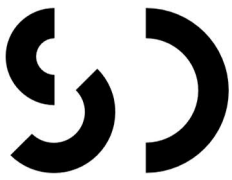
Soil type Organic silty clay
Moist density $\gamma_{\text{mr}} = 15$ kN/m³
Saturated density $\gamma_{\text{sr}} = 15$ kN/m³
Characteristic effective shear resistance angle $\phi'_{r,k} = 22$ deg
Characteristic wall friction angle $\delta_{r,k} = 11$ deg

Base soil properties

Soil type Organic silty clay
Soil density $\gamma_b = 15$ kN/m³
Characteristic effective shear resistance angle $\phi'_{b,k} = 22$ deg
Characteristic wall friction angle $\delta_{b,k} = 11$ deg
Characteristic base friction angle $\delta_{bb,k} = 14.7$ deg
Presumed bearing capacity $P_{\text{bearing}} = 100$ kN/m²

Loading details

Variable surcharge load Surcharge_Q = 1.5 kN/m²
Vertical line load at 2125 mm $P_{G1} = 42.5$ kN/m
 $P_{Q1} = 11.8$ kN/m
Vertical line load at 100 mm $P_{G2} = 3.9$ kN/m
 $P_{Q2} = 0.9$ kN/m



General arrangement - sketch pressures relate to bearing check

Calculate retaining wall geometry

Base length $l_{base} = 2300$ mm
 Saturated soil height $h_{sat} = 1700$ mm
 Moist soil height $h_{moist} = 1000$ mm
 Length of surcharge load $l_{sur} = 0$ mm
 Vertical distance $x_{sur_v} = 2300$ mm
 Effective height of wall $h_{eff} = 3200$ mm
 Horizontal distance $x_{sur_h} = 1600$ mm
 Area of wall stem $A_{stem} = 0.81$ m² Vertical distance $x_{stem} = 2150$ mm
 Area of wall base $A_{base} = 1.15$ m² Vertical distance $x_{base} = 1150$ mm

For undrained soils - Annex C.1(2)

Active pressure coefficient $K_A = 1.000$ Passive pressure coefficient $K_P = 1.000$

Bearing pressure check

Vertical forces on wall

Total $F_{total_v} = F_{stem} + F_{base} + F_{P_v} + F_{water_v} = 108.1$ kN/m

Horizontal forces on wall

Total $F_{total_h} = F_{sur_h} + F_{sat_h} + F_{water_h} + F_{moist_h} + F_{pass_h} = 78.7$ kN/m

Moments on wall

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = 104.1$ kNm/m

Check bearing pressure

Propping force $F_{prop_base} = 78.7$ kN/m

Bearing pressure at toe $q_{toe} = 69.9$ kN/m² Bearing pressure at heel $q_{heel} = 24.1$ kN/m²

Factor of safety $FoS_{bp} = 1.432$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.15

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class C30/37

Char.comp.cylinder strength $f_{ck} = 30$ N/mm² Mean axial tensile strength $f_{ctm} = 2.9$ N/mm²

Secant modulus of elasticity $E_{cm} = 32837$ N/mm² Maximum aggregate size $h_{agg} = 20$ mm

Design comp.concrete strength $f_{cd} = 17.0$ N/mm² Partial factor $\gamma_C = 1.50$



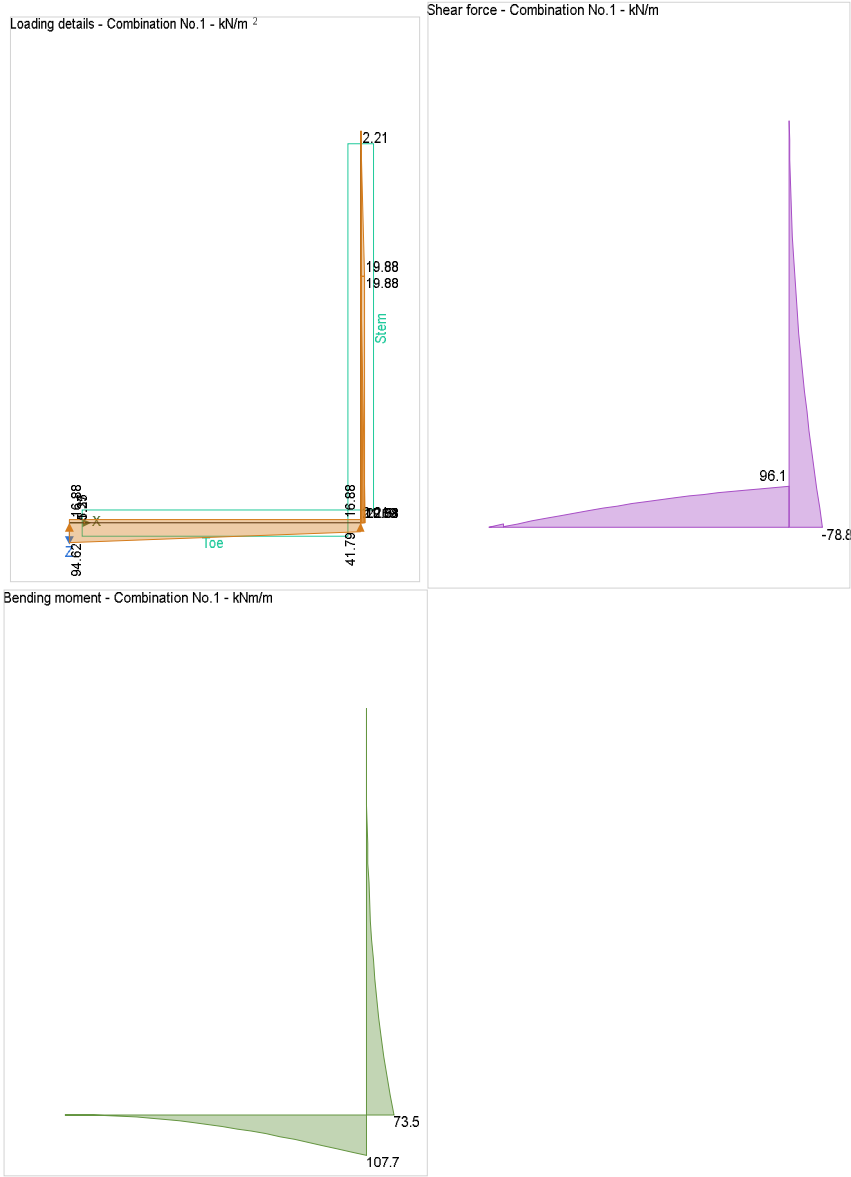
Reinforcement details

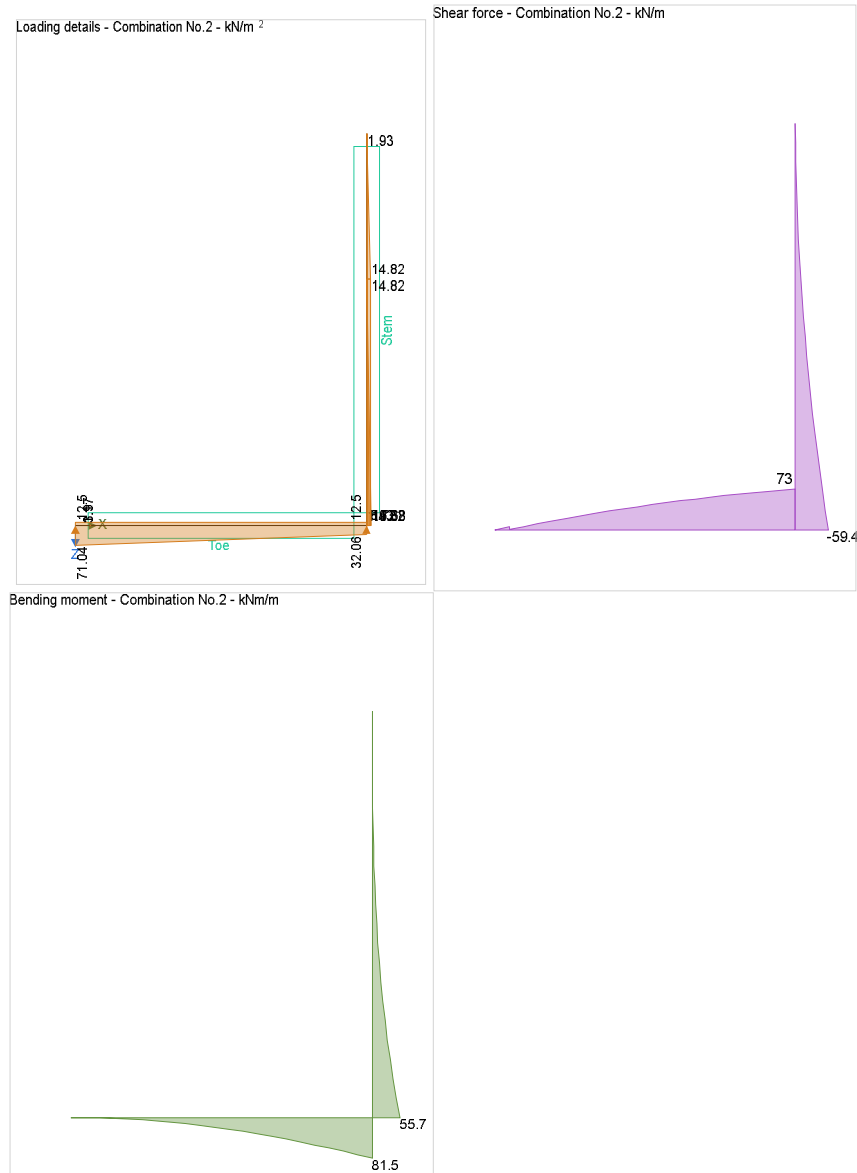
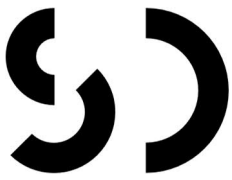
Characteristic yield strength $f_{yk} = 500 \text{ N/mm}^2$ Modulus of elasticity $E_s = 200000 \text{ N/mm}^2$

Design yield strength $f_{yd} = 435 \text{ N/mm}^2$ Partial factor $\gamma_s = 1.15$

Cover to reinforcement

Front face of stem $c_{sf} = 40 \text{ mm}$ Rear face of stem $c_{sr} = 50 \text{ mm}$
Top face of base $c_{bt} = 50 \text{ mm}$ Bottom face of base $c_{bb} = 75 \text{ mm}$





Check stem design at base of stem

Depth of section $h = 300$ mm

Rectangular section in flexure - Section 6.1

Design bending moment $M = 73.5$ kNm/m $K = 0.043$

$K' = 0.207$

$K' > K$ - No compression reinforcement is required

Tens.reinforcement required $A_{sr.req} = 741$ mm²/m

Tens.reinforcement provided 20 dia.bars @ 200 c/c

Tens.reinforcement provided

$A_{sr.prov} = 1571$ mm²/m

Min.area of reinforcement $A_{sr.min} = 361$ mm²/m

Max.area of reinforcement $A_{sr.max} = 12000$ mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single summary

Deflection control - Section 7.4

Limiting span to depth ratio 16 Actual span to depth ratio 11.3

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width $w_{max} = 0.3$ mm Maximum crack width $w_k = 0.158$ mm

PASS - Maximum crack width is less than limiting crack width

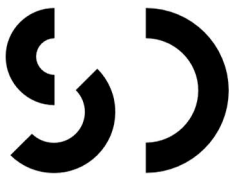
Design shear force $V = 78.8$ kN/m

Rectangular section in shear - Section 6.2

Design shear force $V = 78.8$ kN/m Design shear resistance $V_{Rd.c} = 148.6$ kN/m

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6



Min.area of reinforcement $A_{sx.req} = 393 \text{ mm}^2/\text{m}$ Max.spacing of reinforcement $S_{sx_max} = 400 \text{ mm}$
Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided
 $A_{sx.prov} = 393 \text{ mm}^2/\text{m}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section $h = 500 \text{ mm}$

Rectangular section in flexure - Section 6.1

Design bending moment $M = 107.7 \text{ kNm/m}$ $K = 0.021$ $K' = 0.207$

$K' > K$ - No compression reinforcement is required

Tens.reinforcement required $A_{bb.req} = 628 \text{ mm}^2/\text{m}$

Tens.reinforcement provided 20 dia.bars @ 200 c/c Tens.reinforcement provided

$A_{bb.prov} = 1571 \text{ mm}^2/\text{m}$

Min.area of reinforcement $A_{bb.min} = 625 \text{ mm}^2/\text{m}$ Max.area of reinforcement $A_{bb.max} = 20000 \text{ mm}^2/\text{m}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single summary

Crack control - Section 7.3

Limiting crack width $w_{max} = 0.3 \text{ mm}$ Maximum crack width $w_k = 0.223 \text{ mm}$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force $V = 96.1 \text{ kN/m}$

Rectangular section in shear - Section 6.2

Design shear force $V = 96.1 \text{ kN/m}$ Design shear resistance $V_{Rd.c} = 189.6 \text{ kN/m}$

PASS - Design shear resistance exceeds design shear force

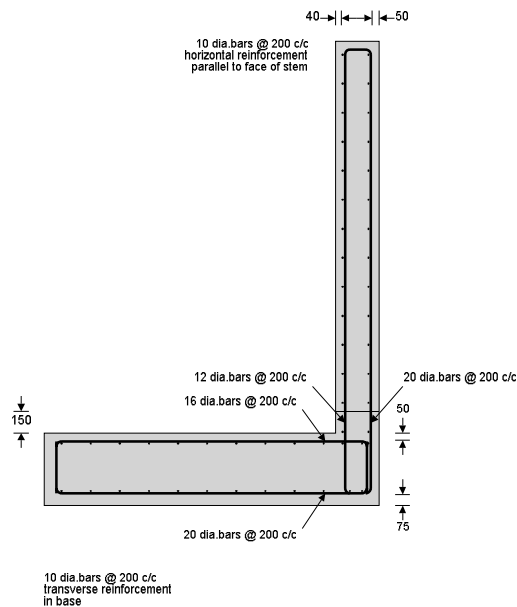
Secondary transverse reinforcement to base - Section 9.3

Min.area of reinforcement $A_{bx.req} = 314 \text{ mm}^2/\text{m}$ Max.spacing of reinforcement $S_{bx_max} = 450 \text{ mm}$

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided

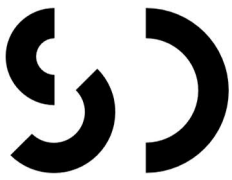
$A_{bx.prov} = 393 \text{ mm}^2/\text{m}$

PASS - Area of reinforcement provided is greater than area of reinforcement required



Reinforcement details

Passes all strength and equilibrium checks for permanent case (water 1m BGL) and accidental case (water at GL) .



Water uplift check

Accidental case - water at ground level
Hence uplift force = $2.7 \times 10 = 27 \text{ kN/m}^2$

Alternatively: for heave acting independently:
Allow 50% to dissipate before construction
Uplift = $18 \times 2.7 \times 0.5 = 24.3 \text{ kN/m}^2$ (< water force, hence design for water uplift)

Net downwards load:
250mm thick RC slab: $DL = 0.25 \times 25 = 5.0 \text{ kN/m}^2$
50mm screed: $DL = 0.05 \times 24 = 1.2 \text{ kN/m}^2$
Finishes: $DL = 0.2 \text{ kN/m}^2$

Hence total downwards load: $DL = 6.4 \text{ kN/m}^2$

Net uplift = $27 - (6.4 \times 0.9) = 21.2 \text{ kN/m}^2$

Slab to span one way between slab thickenings / piles.
Span of slab = 3.15m
Slab top reinforcement to be designed to resist upwards induced UDL.
Load to be resisted at perimeter = $21.2 \times 3.15 \times 0.5 = 33.4 \text{ kN/m}$

Rear wall:
Weight of thickening: $DL = 0.5 \times 1.25 \times 25 = 15.6 \text{ kN /m}$
Hence piles to be designed to resist: $33.4 - (15.6 \times 0.9) = 19.4 \text{ kN/m uplift}$

Intermediate footings: to act as beam between tension piles and perimeter thickenings
Weight of strip footing: $DL = 0.5 \times 0.6 \times 25 = 7.5 \text{ kN/m}$
Hence uplift force = $33.4 - (7.5 \times 0.9) = 26.7 \text{ kN/m uplift}$
Beam top reinforcement to be designed to resist upwards induced UDL.
Reaction at edges: $DL = 26.7 \times 2.65 \times 0.5 = 35.4 \text{ kN uplift}$

Side walls:
Weight of thickening: $DL = 0.5 \times 1.25 \times 25 = 15.6 \text{ kN /m}$
Weight of wall: $DL = 0.25 \times 2.7 \times 25 = 16.9 \text{ kN /m}$
Plus loads above: $DL = 55.6 \text{ kN/m}$
Hence no net uplift force. Thickenings and wall sufficient.

Pad foundations:
Weight of thickening: $DL = 0.5 \times 1.8 \times 1.8 \times 25 = 40.5 \text{ kN}$
Column reaction: $DL = 75.4 \text{ kN}$

Uplift reaction from slab: $DL = 33.4 \times 1.8 = 60.1 \text{ kN}$
Uplift reaction from 2 strip thickening 'beams': $DL = 2 \times 35.4 = 70.8 \text{ kN}$

Hence net uplift force = $(60.1 + 70.8) - (0.9 \times (40.5 + 75.4)) = 26.6 \text{ kN}$
Hence each pile to be designed to resist: $26.6 / 2 = 13.3 \text{ kN uplift}$

All piles to resist tension forces created by water uplift.

All concrete top reinforcement to be designed to take induced UDL with detailed design.



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